



IAEA

International Atomic Energy Agency

IAEA Activities in Support of Research Reactors

Ram Sharma

Head, Research Reactor Section

**RROG 2019, 30th Annual Meeting 14-17 May,
Institut für Kernchemie, TRIGA Forschungsreaktor Mainz (FRMZ)**

- **Introduction**
- **Current Status of Research Reactors**
- **IAEA activities:**
 - **Objectives**
 - **RR infra-structure and capacity building**
 - **Operation, Maintenance, Upgrades**
 - **Utilization and Application**
 - **Fuel Cycle and HEU minimization**
 - **IAEA Safety Program for Research Reactors**
- **Conclusions**

IAEA RRDB Overview



21 Sep 2018

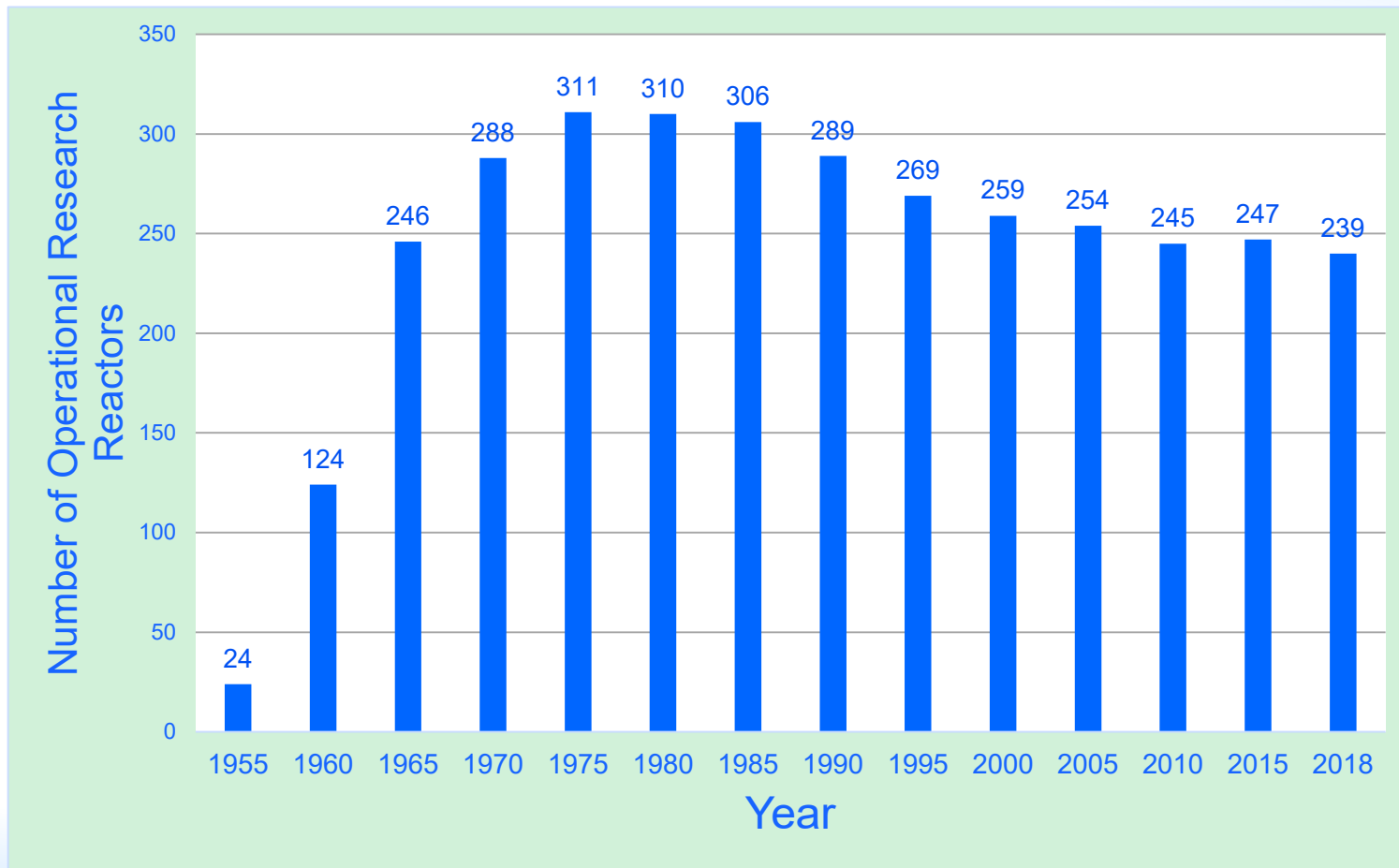
Status	Developed Countries	Developing Countries	All Countries
Planned	2	12	13
Under construction	4	5	9
Operational	140	86	226
Temporary shutdown	8	5	13
Extended shutdown	5	8	13
Permanent shutdown	42	14	56
Under decommissioning	63	4	67
Decommissioned	413	29	443
Total	677	163	840

818 built

IAEA RRDB Overview

Numbers of operational research reactors

21 Sep 2018



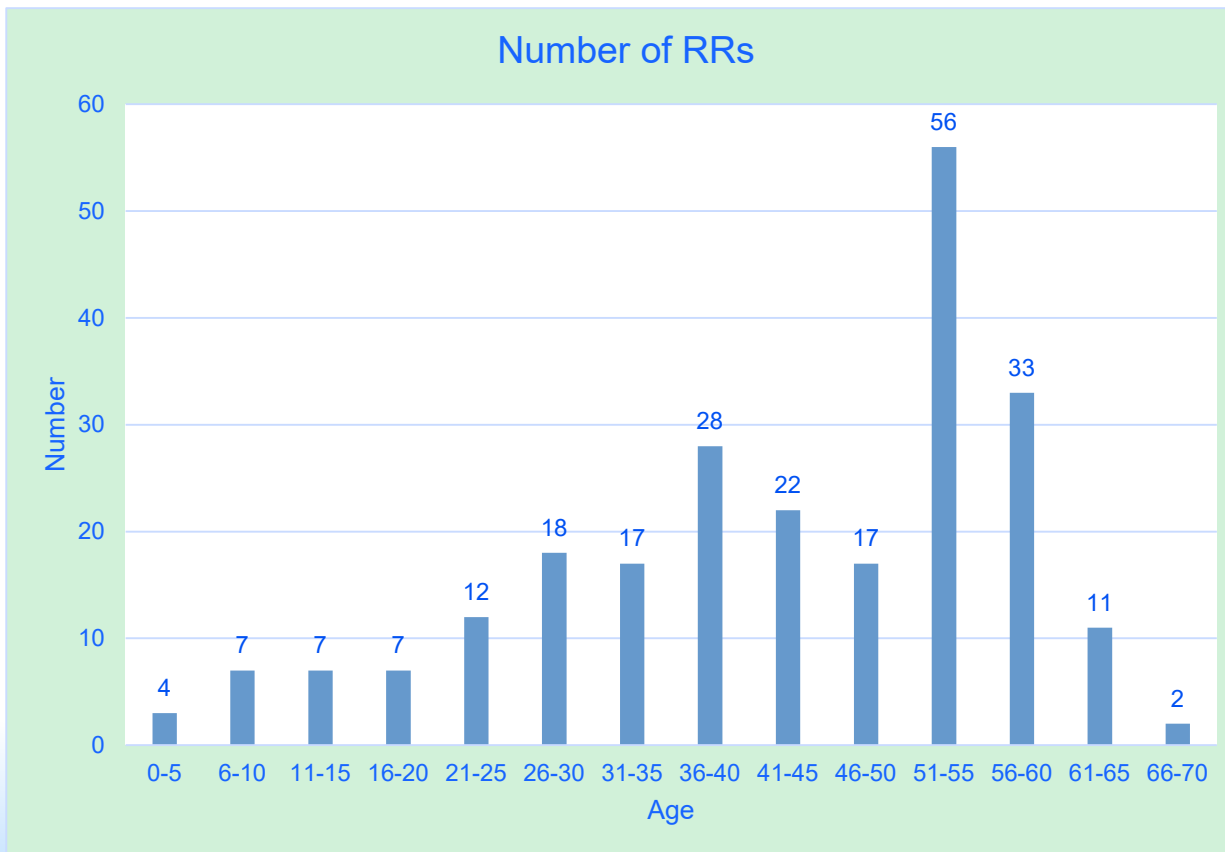
IAEA RRDB Overview

21 Sep 2018

Ageing status

60% of operating RRs are over 40 years old.

43 % of operating RRs are more than 50 years old.



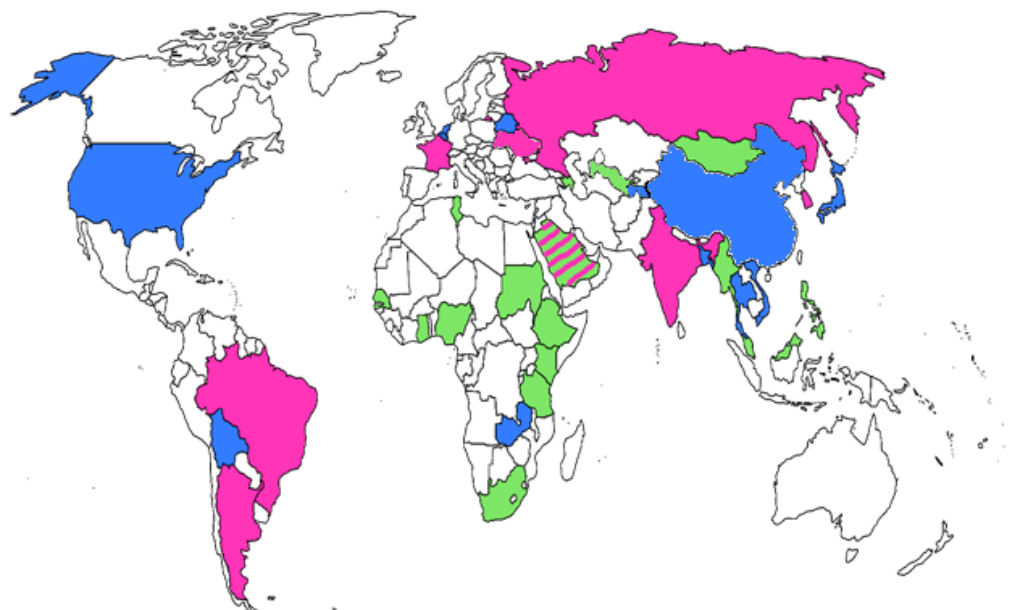
Old RRs:
Difficult to
manage
and or replace

Ageing
Management,
Modernization
and
refurbishment

New RR Projects: tentative overview

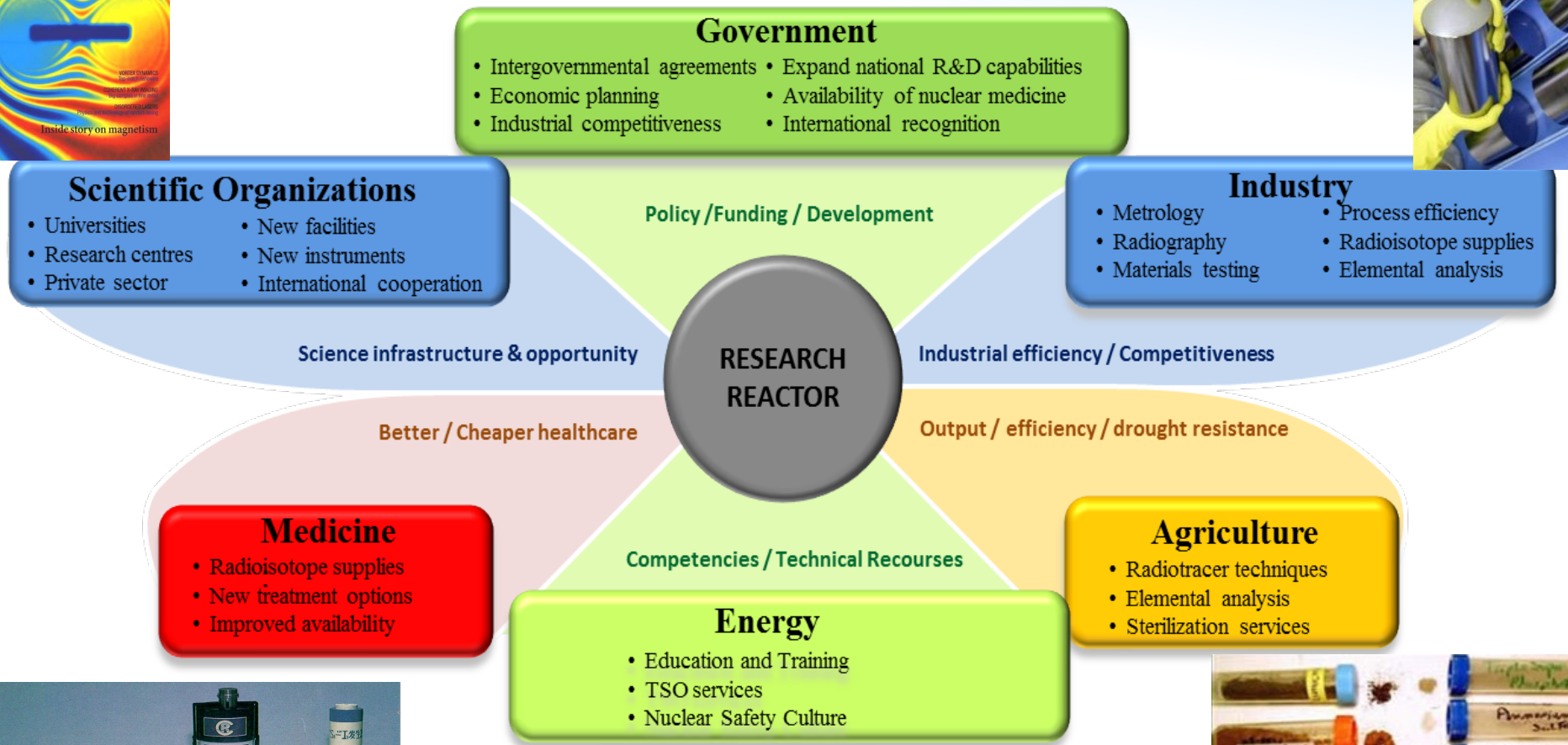
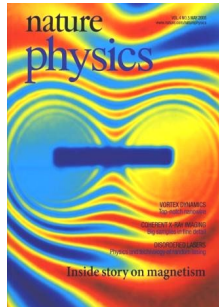
Phase 1 (Consideration)	Phase 2 (Preparatory Work)
Azerbaijan Ethiopia Ghana Kenya Malaysia Mongolia Myanmar Tajikistan Philippines Nigeria Saudi Arabia (Multipurpose RR) Senegal South Africa Sudan Tanzania Tunisia Total:16	Bangladesh Belarus Belgium Bolivia China (2) Japan The Netherlands Tajikistan Thailand USA Viet Nam Zambia Total:13
	Phase 3 (Implementation)
	Argentina (2) Brazil France India (2) Republic of Korea Russian Federation (3) Saudi Arabia (Low Power RR) Ukraine (subcrit) Total:12

2019



New RR more geared towards Education and Training or Radioisotope production

RR stakeholders and users





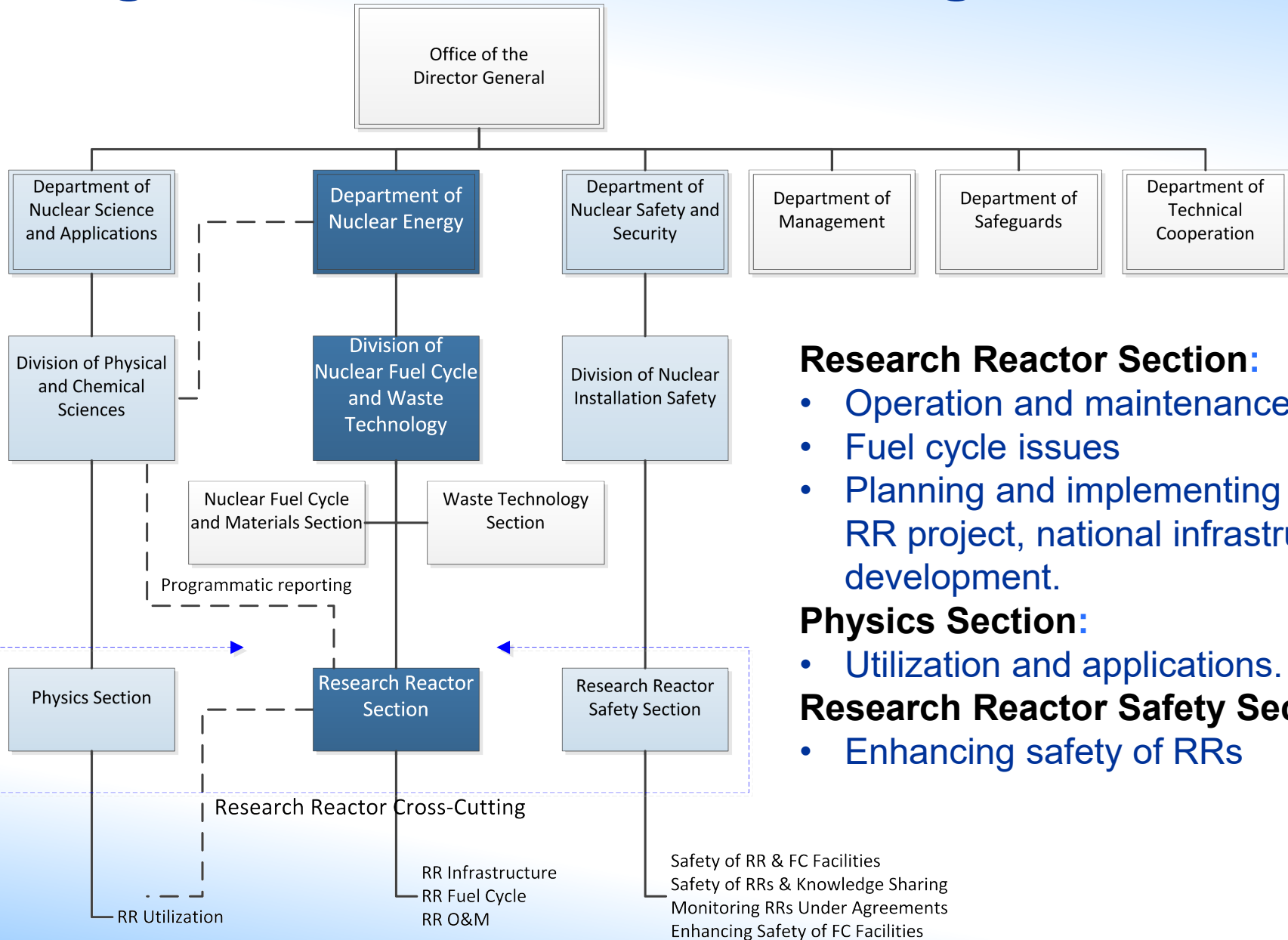
IAEA

International Atomic Energy Agency

Objectives

- **To support Member States in ensuring sustainable operation and effective utilization of existing research reactors on long term basis with enhanced safety, availability and reliability**
- **To support Member States in nuclear capacity building based on the use of and access to RRs**
- **To support Member States in planning and implementing new research reactor projects, including the development of their national infrastructure**

Organization for IAEA RR Program



Research Reactor Section:

- Operation and maintenance
- Fuel cycle issues
- Planning and implementing new RR project, national infrastructure development.

Physics Section:

- Utilization and applications.

Research Reactor Safety Section:

- Enhancing safety of RRs

- **Consultancy Meetings – specific focus**
- **Technical Meetings**
- **Training Workshops / Training Courses**
- **International Conferences and Symposia**
- **Coordinated Research Projects (CRP)**
- **Peer Review Missions and Expert Missions**
- **Establishment of networks and coalitions**
- **Technical Cooperation projects related to RRs**
- **NDE and ISI support**
- **Publications (standards, guidance, and other documents)**
- **IAEA Databases**
 - ✓ RRDB (Research Reactors Database)
 - ✓ RRADB (Research Reactors Ageing Database)
 - ✓ RRMPDB (Research Reactors Material Properties Database)
- **Technical Working Group on RRs**

- **Peer Review Missions to provide advice and assistance to MSs**
 - ✓ OMARR
(Operations and Maintenance Assessment of Research Reactors)
 - ✓ INIR-RR
(Integrated Nuclear Infrastructure Review of Research Reactors)
 - ✓ INSARR
(Integrated Nuclear Safety Assessment of Research Reactors)
 - ✓ IRRUR
(Integrated Research Reactors Utilization Review)
- **Establishment of networks and coalitions;**
 - ✓ Nuclear safety networks,
 - ✓ Regional advisory safety committees,
 - ✓ Internet Reactor Laboratory (IRL),
 - ✓ Int'l Centres based on Research Reactors (ICERR)
 - ✓ EERRI group fellowship course
 - ✓ Regional Research Reactor Schools

Operation, Maintenance, Upgrade

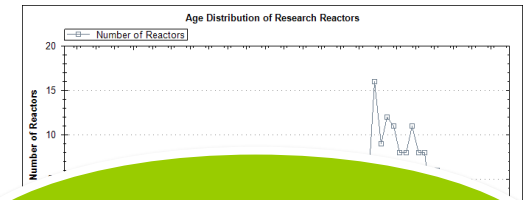
Bases:

- Adequate life management programmes (ageing management and refurbishment/upgradation programmes).
- Adequate O&M plans & management system.
- Funding reduction for such facilities and limited succession planning, development, implementation of sound O&M, life management programmes.
- Two thirds of the RRs are in permanent shut-down state and need decommissioning.



Objectives; To assist MSs in developing and implementing

- **Operation and Maintenance plans** to improve facility's operational performances and in establishing **Integrated Management Systems**
- **Ageing Management and Renovation/Upgrade programmes** for facility's life management
- **Decommissioning**



OMARR and
INSARR reviews

Ageing
Management
Data Base

DACCORD
Project



Technical Meetings

- Ageing Management, Refurbishment and Modernization of research reactors (every two-years, held in Oct 2017, next in 2020 with IGORR)
- Upgrades to Digital Instrumentation and Control Systems for Research Reactors (every two years, held in Jul 2017, next in July 2019)
- Good Operating Practices and sharing of experience (held in Oct, 2018; next 2019/2020)
- International Conference on Research Reactors: Addressing Challenges and Opportunities to Ensure Effectiveness and Sustainability (25–29 November 2019, Buenos Aires, Argentina)
- ISI, NDE and On Line Monitoring (OLM) techniques (every two-year; June 2018)
- Integrated Management Systems (IMS) (every two-year; planned in 2019)
- Planning for decommissioning / Managing transition from permanent shut down to decommissioning

OMARR review missions

- Provides advice to Member States in enhancing the performance of research reactors by identifying areas for improvement, addressing specific operational challenges and creating a space for sharing experiences and good practices.
- Pre-OMARR - A preparatory Mission of 2–3 days
- Main OMARR - main mission of 5–7 days
- Post-OMARR - follow up mission of 3-5 days if required by the facility
- Outcome: More efficient and reliable long-term operation of a research reactor with improved safety culture and optimum utilization of human and financial resources.

Support to Infrastructure Development

Bases:

- *Planning or building the first RR in several MSs.*
- *Establishment of national infrastructure to ensure that national and international commitments and obligations, particularly regarding safety, security, safeguards and emergency preparedness, are met during construction, operation and decommissioning*



Objectives:

- planning and implementing **new RR projects**, including the assessment and development of their national nuclear **infrastructure**, Milestones approach, **INIR – RR** peer review mission and follow-up



Step Wise Approach From Considering a new RR to Decommissioning

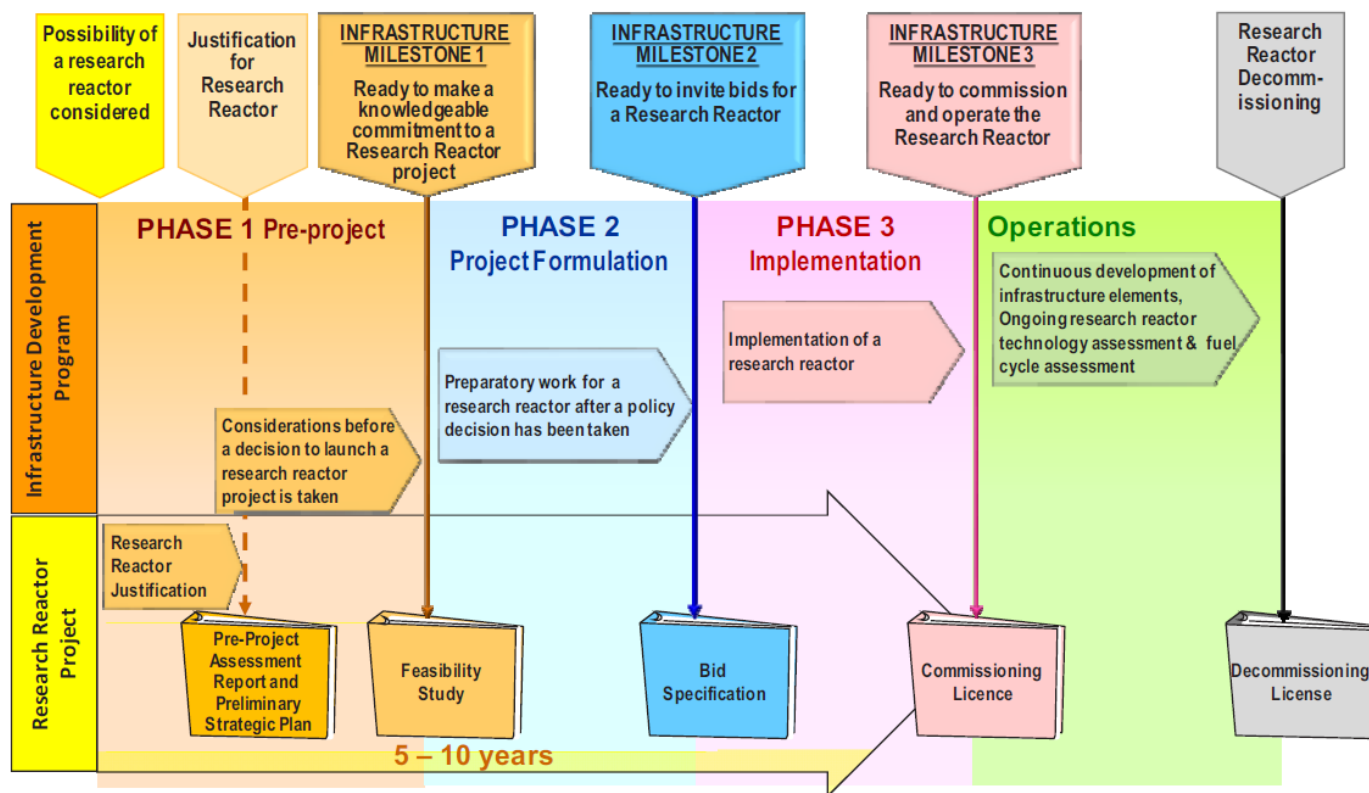


FIG. 1. Research reactor project and infrastructure development programme.

Access to Research Reactor

Nuclear Capacity Building based on Research Reactors



Distance Training:
Internet Reactor
Laboratory (IRL)

Basic Training:
Regional Research
Reactor Schools



To support Member States,
- to operate Research Reactors
- to develop nuclear competences
- to embark into a national nuclear programme.

Intermediate Training:
EERRI Group
Fellowship Course

Advanced Training at
International
Centres based on
Research Reactors (ICERRs)



Internet Reactor Laboratory (IRL)

- Connects through internet an operating research reactor - Host reactor - to Guest institutions, generally Universities within the same region.
- Opportunity to add a practical component to academic programmes in nuclear engineering and nuclear physics, when access to an operating research reactor in the country is not feasible.
- 5 or 6 half day sessions broadcasted every year (Approach to criticality, rod calibration, temperature effect, ...)

Sessions broadcasted 2016, 2017 & 2018 (in 3 years, 175 students form 7 MSs),

- Latin America, CNEA-RA6 (Argentina) to Colombia, Cuba, Ecuador
- Europe + Africa, CEA-ISIS (France) to Belarus, Lithuania, Tanzania, Tunisia



Internet Reactor Laboratory (IRL)



Internet Reactor Laboratory (IRL)



Activities Planned in 2019:

- VR-1 in Czech Republic to Replace CEA-ISIS (shut down since Dec 2018, termination of agreement under processing)
 - signing of agreements between new host and old guests (Lithuania, Belarus, Tanzania, Tunisia)
 - Shifting of equipment from ISIS to VR-1 or new one
 - First Transmission in Q4/2019
- **Africa:** MA1 in Morocco as host and Kenya and South Africa as Guests
 - Agreements signed (2018)
 - Equipment and Software delivered
 - Orientation workshop and first Transmission during Q3 2019
- **Far East:** AGN-201 K in Republic of Korea as host and Mongolia, Azerbaijan and Philippines as guests
 - Agreements signed (2017 and 2018)
 - Equipment and Software delivered
 - Orientation workshop and first Transmission during Q3 2019.

Internet Reactor Laboratory (IRL)

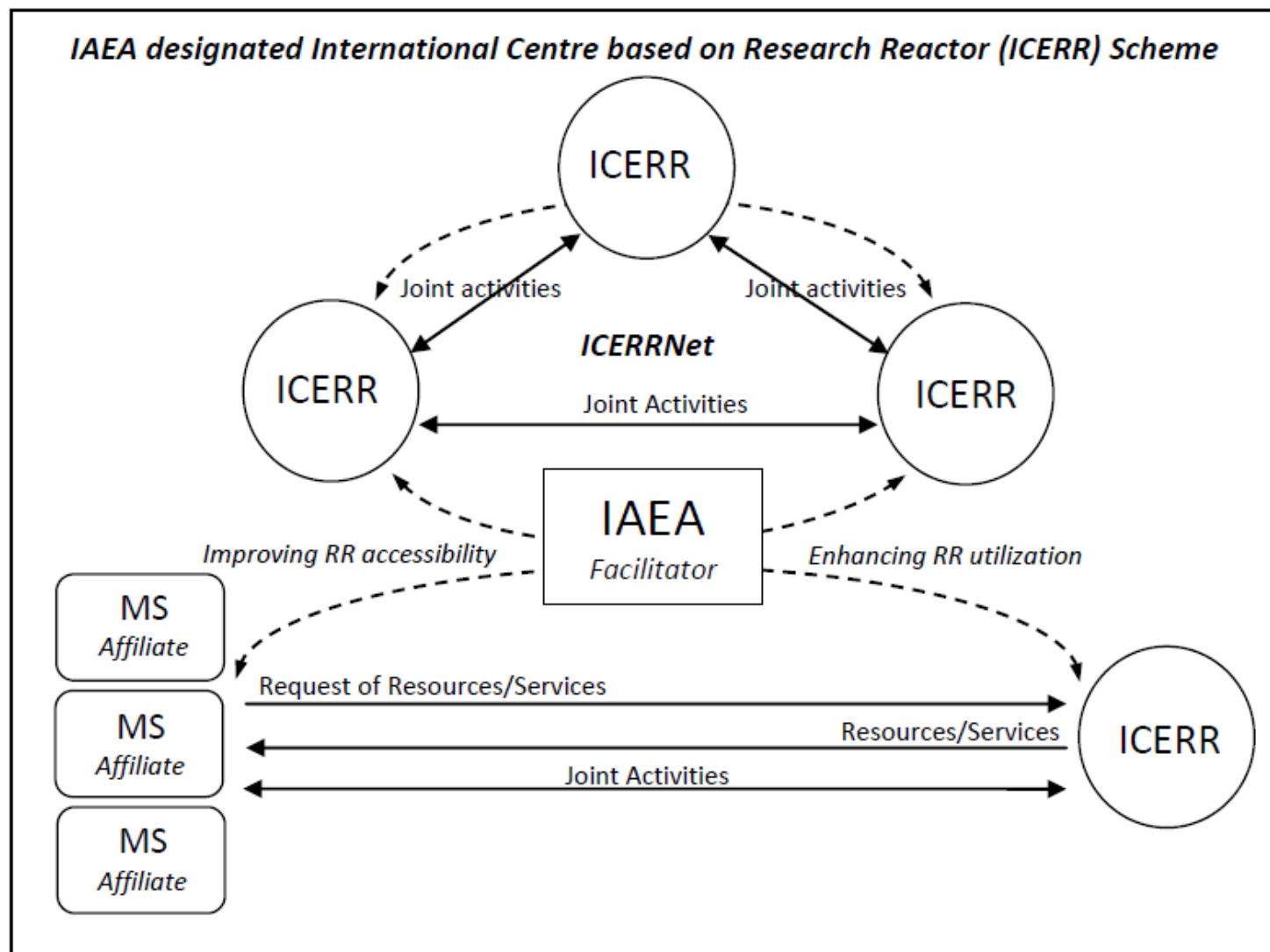


Activities Planned in 2019:

- South East Asia and Pacific: Indonesia
 - Universities within the country
 - Probable Hosts in future
 - MEPhi (Russian Fed)

- Probable Guests in Future
 - Bolivia, Bulgaria, Poland, Niger, Senegal, Zambia, Niger, Sudan, Ethiopia, Tanzania, Rwanda, Ghana, Myanmar, Tajikistan, Uruguay, Jamaica, Spain, Senegal

ICERR Scheme



ICERRs

- Designated ICERRs (Four):
 - CEA (France) in 2015
 - SSC RIAR (Russian Federation) in 2016
 - SCK-CEN (Belgium)
 - US DOE ORNL-INL (USA) at GC 2017,
- Under Consideration:
 - KAERI, Republic of Korea
 - ICN in Pitesti, Romania

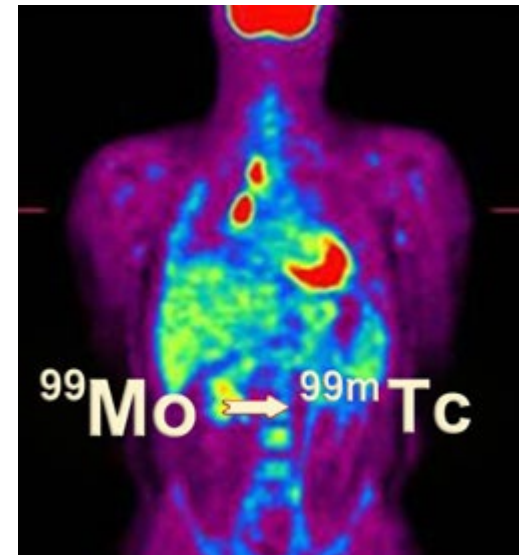
Utilization and Applications

Bases:

- *Efficient utilization and well management for sustainable operations.*
- *Strategic planning and Considerations on repurposing a RR*

Objectives:

- **Enhancing RR utilization** for applications, such as isotope production, use of neutron beams, irradiation and analytical services, material characterization and testing, nuclear education and training,
- To assist **RR centres in development of user communities and industrial partnership**



Addressing Fuel Cycle Issues

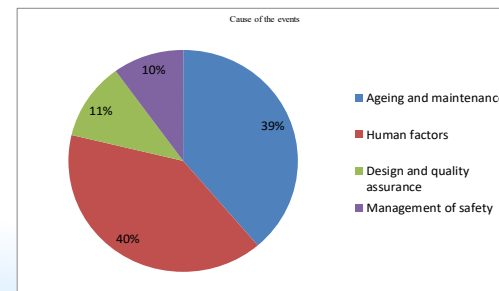
Objectives:

- Assurance of fresh fuel supply
- Development and qualification high density LEU fuel (for high power RR core conversion from HEU to LEU).
- Assistance to MSs, upon request, with the Core conversion from HEU to LEU Fuel and repatriation of SNF to its country of origin.
- Safe, reliable and economic management of Spent Nuclear Fuel (SNF) and back end options.



Safety issues

- ❑ Identification of safety issues and challenges.
- ❑ Update of programme and activities.
- ❑ Main sources of information;
 - Feedback from ‘Code of Conduct’ meetings;
 - ✓ Self-assessments by 40 countries – International Meeting on Code of Conduct (2017) and the areas needing improvements are identified.
 - ✓ Main areas needing improvements: Resources (human and financial); Safety assessment; Decommissioning planning; Ageing management; Management system, and Culture for safety.
 - Feedback from IAEA safety reviews.
 - Feedback from the IRSRR;
 - ✓ Human Factors and Component Ageing are the two most important root causes of the incidents reported to the IRSRR.



IAEA Safety Program for RRs

- ❑ **Application of the IAEA Safety Standards will help for the highest level of safety.**
- ❑ **The IAEA programme on the safety of RRs gives priority to the development and promotion of proper use of the IAEA Safety Standards through:**
 - Maintaining and expanding worldwide application of the Code of Conduct and the IAEA safety standards;
 - Supporting on ageing management and fuel cycle facilities;
 - Enhancing regulatory effectiveness, including infrastructure for the first research reactor projects;
 - Monitoring safety under Project and Supply Agreements – 27 research reactors in 23 countries;
 - Supporting on safety reassessments following the Fukushima accident;
 - Improving management of the interface between safety and security;
 - Improving exchange of operating experience through Incident Reporting System for Research Reactors (IRSRR) and networking.

Conclusions

- RRs are indispensable tools to support R&D, applications in industry, medicine and agriculture, and human resource development - needed for the next 50 years or more.**
- Agency support available to Member States in all aspects of RRs starting from Design to Decommissioning**
- The focus will be on**
 - Enhancing safety, operational performance and utilization of RRs.**
 - Managing transition between permanent shut down and decommissioning**
 - Decommissioning of permanently shut-down RRs**
 - Enhancing regional cooperation, networking and sharing of available resources and experience.**



60 Years

IAEA

Atoms for Peace and Development

Only One Option

Increase international cooperation

Facilitate access to research reactor

Ensure best use of existing limited assets

The IAEA is committed to help !



IAEA

60 Years

Atoms for Peace and Development

Thank you!

